(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 337 112 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
20.08.2003 Bulletin 2003/34

(51) Int Cl.[7]: **H04N 7/24**

(21) Application number: **02425077.1**

(22) Date of filing: **14.02.2002**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(71) Applicant: **RAI RADIOTELEVISIONE ITALIANA (S.p.A.)**
00195 Roma (IT)

(72) Inventors:
- **Morello, Alberto**
  Torino (IT)
- **Visintin, Michele**
  Torino (IT)
- **Alberico, Gino**
  Torino (IT)
- **Bertella, Andrea**
  Borgaro Torinese (Prov. of Torino) (IT)
- **Sacco, Bruno**
  Torino (IT)

(74) Representative: **Spandonari, Carlo, Dr. Ing.**
Spandonari & Modiano s.r.l.
corso Duca degli Abruzzi 16
10129 Torino (IT)

(54) Process for transmitting digital television signals for multi-frequency terrestrial digital networks (DVB-T)

(57) Digital television signals comprising a plurality of elementary binary streams, representing respective television programs, are multiplexed into a single, low-capacity transport stream, which also incorporates PSU/SU tables packets, PCR packets and null packets. The transport stream is then modulated and transmitted to a plurality of terrestrial stations, for broadcasting by terrestrial antennas. Before modulation, the packets transporting PSI/SI tables of type PAT, SDT, NIT e EIT are masked by replacing their respective PIDs with respective, predetermined, hiding PID values, chosen among values that are not reserved for satellite reception, and their "priority" bits are set. The resulting transport stream is then re-multiplexed to generate a high-capacity transport stream for transmission. At reception, the packets having unset "priority" bits are marked as null, and the original PIDs in the packets transporting the previously hidden PSI/SI tables (PAT, SDT, NIT e EIT) are restored.

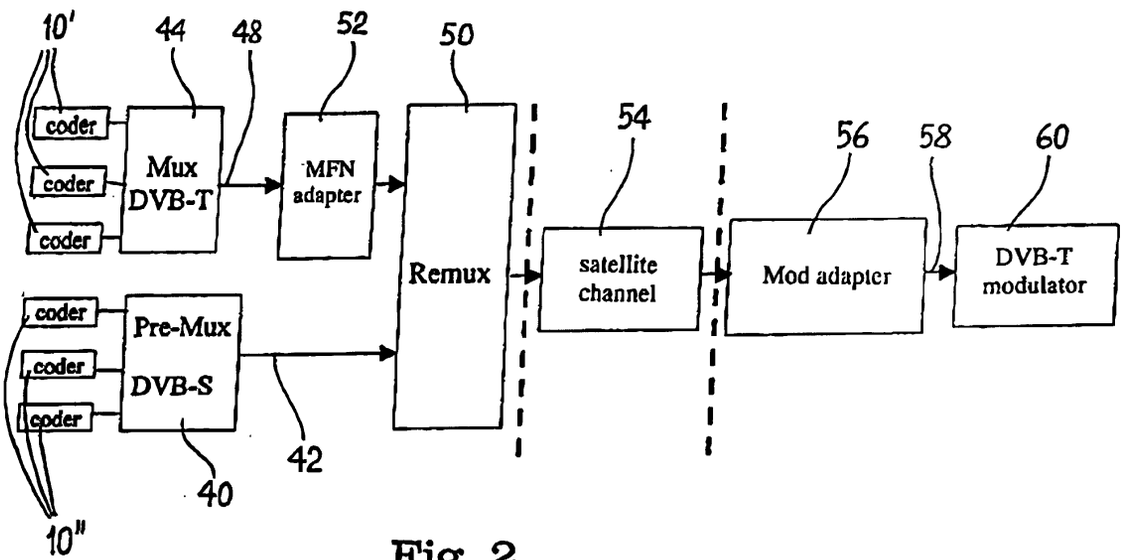

Fig. 2

EP 1 337 112 A1

Description

[0001] This invention is concerned with a process for transmitting digital television signals for multi-frequency terrestrial digital networks (DVB-T), particularly for transmitting digital television programs.

[0002] Digital television is based on the MPEG coding, wherein, as known, one or more streams of elementary packets (video, audio, or data packets) are generated by coders and then combined with great flexibility into a single binary stream, or transport stream that is suitable for transmission. The transport stream incorporates all the information required for achieving synchronization, decoding and display of the audiovisual contents.

[0003] More in detail, a transport stream is built within the MPEG coding by multiplexing the elementary binary streams coming from the coders into a single sequence of packets. All the packets forming an elementary stream (be it audio, video or data) are identified by an identifier code, known as PID (Packet IDentifier). Beside such information packets, the multiplexer also generates and inserts within the transport stream auxiliary information packets, which are also identified with their own PID, which include a set of PSI tables (Programme Specific Information), which are defined in the ISO/IEC 13818-1 standard and a set of SI tables (Service Information), which are defined by the ETSI ETS 300 468 standard. These will be discussed in more detail below. Moreover, since the data packets generated by the individual coders appear with a widely variable rate, the multiplexer inserts also a suitable number of null packets in the transport stream, which null packets have the only purpose of smoothing the stream, although they contain no useful information.

[0004] By the above technique of multiplexing a number of television programs onto a single transport stream it is now possible to feed analog terrestrial transmitters via satellite links. As known, the typical capacity of a satellite channel for digital television signals in the DVB-S standard is of about 34 Mbit/s, while the capacity of a terrestrial channel (VHF and UHF bands) using the DVB-T standard is considerably smaller, i.e. about 20 to 24 Mbit/s. Feeding terrestrial transmitters in a multifrequency network by transmitting a digital multiplex via a high-capacity satellite link (in the DVB-S standard) is technically feasible and is known to persons skilled in the art, for instance, according to the diagram shown on Fig. 1.

[0005] With reference to Fig. 1, a number of coders 10 process and compress respective digital television signals to produce respective binary streams which are then applied to a digital multiplexer 12. The individual streams are here multiplexed and PSI/SI tables 14 are inserted, so that an overall transport stream is issued on an output 16 and is then modulated onto a 34-MHz channel 17 by means of a DVB-S modulator 18. The modulated stream is then transmitted from an up-link station 20 to a satellite transponder 22. From the satellite, the signal is then broadcast to several terrestrial stations, among which, for instance, are an individual DVB-S receiver 24, where the signal is immediately used for display, and a DVB-S receiver 26, which demodulates the transport stream received and feeds it to a terrestrial broadcast installation comprising a remultiplexer 28 (also called remux) which extracts from the stream a portion of the television signals contained in it, by relying on the PSI/SI tables, and remultiplexes the extracted signals into a fresh stream 30 at 20 Mbit/s, while inserting into it fresh, regenerated PSI/SI tables 32. The new, remultiplexed stream is applied to a DVB-T modulator 34 to be broadcast by a terrestrial antenna 36.

[0006] The above operating technique can be economically advantageous for the network manager, who is thereby enabled to serve users having satellite receivers as well as to feed terrestrial transmitters broadcasting to users who are only provided with terrestrial receivers. However, the technique has the inherent drawback that it requires that the tables describing the configuration of the digital multiplex (PSI and SI tables as defined by MPEG and DVB, respectively) be updated at the local level, on the sites of the terrestrial transmitters, thereby making it difficult for the network administrator to maintain centralized control. Because of this, operating problems may arise during any reconfiguration of the service (e.g., when changing from four programs at 5 Mbit/s to five programs at 4 Mbit/s. Moreover, remux 28 is a complex and expensive apparatus, which is underused in this kind of application. The complexity of the remultiplexer is due to the requirement of processing all timing references (called PCR in the ISO/IEC 13818-1 standard) which allow the terrestrial receivers to synchronize with the 27-MHz sampling clocks of the video coders 10. According to the above standard, such processing of the PCRs should be carried out by any apparatus which modifies the bit-rate of the Transport Stream (e.g., by adding or taking away packets to the Transport Stream, which are typical operations performed by re-multiplexers). If one considers that the transmitting sites where this apparatus must be installed can be quite numerous (e.g., the transmitters of a national network may be several hundreds to over one thousand), the overall cost of this approach can be definitely exorbitant.

[0007] Accordingly, the main object of the invention is to provide a process by which a number of terrestrial stations can be fed, via a satellite link, with DVB-T programs which are to be broadcast by respective antennas at different frequencies, without having to provide each of the transmitters with an expensive remultipexer. In other words, the invention, on the basis of the satellite-emitted binary stream, aims at providing a binary stream that is suitable for terrestrial broadcasting at each of the transmitters of a multi-frequency network, by means of special processing of the binary stream at the central generation chain and a corresponding

processing of the stream received from the satellite.

[0008] The above and other objects and advantages, such as will appear from the following disclosure, are attained by the invention by a process for transmitting digital television signals having the features set out in claim 1.

[0009] The invenzion also provides a process for receiving digital television signals having the features set out in claim 3.

[0010] Other advantageous features of the invention are set out in the subordinate claims.

[0011] Preferred embodiments of the invention are disclosed below, with reference to the attached drawings, wherein:

Fig. 1 is a block diagram showing a satellite link from a central generating station to a number of receiving stations, among which is a terrestrial multi-frequency broadcasting station; and

Fug. 2 is a partial block diagram, similar to Fig. 1, modified according to the teachings of the invention.

[0012] The approach of the invention is to multiplex a desired number of elementary streams, corresponding to respective television programs and intended for feeding to one or more terrestrial, multi-frequency networks, into a single low-capacity binary stream, which is then remultiplexed in conventional fashion with other elementary streams into a high-capacity stream for satellite transmission. The receiving stations of the terrestrial network process the entire stream to obtain a final signal whose payload is equivalent to the initial, low-capacity stream. The signal received at the terrestrial stations is not processed by a conventional remux, but rather by means of a considerably simpler apparatus which takes advantage from the processing of the initial stream in the stream-generating chain. However, the operation of the above process for transmitting digital signals requires that some of the service information contained in the low-capacity stream is preserved through their remultiplexing into the high-capacity stream, so that it can then be utilized during processing at the terrestrial station. This condition can be satisfied by the teachings of the invention, so that the above inventive approach can be implemented.

[0013] Fig. 2 is a block diagram of a transmission and reception chain through a satellite link, and is similar to the block diagram of Fig. 1, but is improved according to a first embodiment of the invention. Reference numbers on Fig. 2 are, where appropriate, the same as on Fig. 1.

[0014] With reference to Fig. 2, a first group of coders 10' receive television programs intended for broadcasting to final users via satellite and for feeding to a multi-frequency terrestrial network, while a second group of coders 10" receive television programs intended for different users, typically only for the final satellite users. The coders in both groups process and compress the respective signals conventionally.

[0015] The elementary output streams of coders 10" are applied to a digital DVB-S pre-multiplexer 40, known per se, which generates, on an output 42, a transport stream containing, in conventional manner, appropriate PSI/SI tables, as well as a suitable number of null packets.

[0016] The elementary output streams from coders 10', on the other hand, are applied to a DVB-T multiplexer 44, where the stream is provided with appropriate PSI/SI tables, as well as with the required null packets, thereby generating stream 48.

[0017] At the end, both partial transport streams 42 and 48 are to be remultiplexed in a multiplexer 50, where, however, all the auxiliary information is liable to changes, since the PSI/SI tables are re-generated, and the input null packets are ignored and are re-generated according to the requirements of the stream. On the other hand, if the low-capacity stream 48 is to be reconstructed at reception so that it contains a payload equivalent to the original payload, it will be understood that at least the following service information is to be preserved:

- the PAT table (Program Association Table): it is unique, its PID is 0x0000, and lists an identifier for each program, which is unique in the network to which the stream belongs, and contains the PID of the PMT table;

- the SDT table (Service Description Table): it is unique and its PID is 0x0011; it contains, for each program in the binary stream, its identifier and other information such as the program name (e.g. RAI1, RAI2, ...) and its producer (e.g. RAI);

- the NIT table (Network Information Table): it is unique, its PID is 0x0010; it contains tuning and modulation parameters for the binary stream (frequency, symbol rate, coding rate, etc.), which depend on the type of metwork (satellite, cable or terrestrial);

- the BIT table (Event Information Table): it is unique, its PID is 0x0012; it contains text information concerning the program schedule (title, starting and duration timetable, description of the current and the following broadcasts).

[0018] For all the above items of information, according to the process of the invention, the stream is processed in an apparatus 52, which is here called MFN adapter (Multi Frequency Network Adapter), having the task of changing the original PID of the PAT, SDT, NIT and EIT tables into a respective hiding PID, which is chosen to a value not reserved in the DVB standard. Con-

sequently, all the packets that have been newly labeled this way are not recognized as tables by remultiplexer 50, and are reintroduced as generic data, without incurring any change, into the final transport stream that is to be modulated on a carrier and transmitted over the satellite link.

[0019] Furthermore, in order to simplify the management of the network, it is provided that the packets belonging to the low-capacity terrestrial stream are marked by setting the "priority" bit that is contained in the packet heading according to the above mentioned DVB standard.

[0020] The operation steps to be performed on the binary stream, as described above, can be easily carried out, e.g. by a computer programmed with a so-called "filter program", as well known in data processing, and easy to be assembled for carrying out the steps described above, according to techniques well known to a person skilled in the art.

[0021] Remultiplexer 50, which receives at its input both the DVB-T and the DVB-S streams, will take care of generating PSI/SI tables that are consistent with the overall program stream (PAT, SDT, NIT e EIT), valid for DVB-S transmission, and of correcting the information contained in the valid PCRs of the respective streams, including the terrestrial stream.

[0022] In the receiving station, a complementary apparatus 56, which is here called modulation adapter, or mod adapter, then has the task of creating a transport stream having a payload equivalent to the original terrestrial payload and of restoring the information that was hidden by MFN adapter 52.

[0023] Mod adapter 56 shall therefore:

- identify the services to be eliminated, based on the value of the priority bit in each packet;
- logically, and not physically, eliminate the identified service packets, the satellite-related PSI/SI tables, the satellite-related PCRs, by marking them as "null packets" (PID=8191): in practice, their respective PIDs are changed to 8191;
- restore the original values of the PIDs in the packets carrying the PSI/SI tables for the terrestrial services (PAT, SDT, NIT e EIT), which had been previously hidden by the MFN adapter.

[0024] This procedure generates an output stream 58 having a gross bit rate equal to the satellite stream, but a payload equal to the original terrestrial stream 48. With respect to the conventional approach of Fig. 1, where the bit rate is changed from the input to the output of the remultiplexer, this procedure gives rise to a considerable practical simplification. On the one hand, since the bit rate of an MPEG Transport Stream does not change, processing the time references in the PCRs is not required. On the other hand, while the conventional approach, where the bit rate is changed from the input to the output of the remultiplexer, it is necessary to generate a local output clock, typically by a loop-locked ring, in the approach proposed by the invention such a step is not necessary, because the input clock and the output clock are the same. However, it should be noted the the bit rate of the initial stream 48 (which, as stated, coincides with the bit rate of the payload 58) cannot be higher than the nominal bit rate of the selected

[0025] DVB-T modulation.

[0026] Conventional DVB-T modulators include, if used in the MFN mode, a device that is generally called TSA (Transport Stream Adapter) or Rate Adapter, whose purpose is to uncouple the modulation timing (channel clock) from the timing of the incoming data (network clock), as well known to the persons skilled in the art. This operation is performed by eliminating or adding "null packets" until the bit rate available in the chosen mode is reached, and by processing the PCR timing references (this procedure is required in the above mentioned MPEG standard at each change of the bit rate of the Transport Stream). Accordingly, the invention takes advantage from the latter functionality of DVB-T modulators for simplifying the mod adapter, which therefore operates at the same bit rate at input and at output, and does not process the PCRs.

[0027] The output 58 of Mod adapter 56 is then applied to a conventional DVB-T modulator 60, which generates the binary stream that is to be broadcast by the terrestrial antenna (not shown).

[0028] For the implementation of the mod adapter, the same indications given for the MFN adapter hold true, since the type of operations is the same.

[0029] Alternatively, according to another embodiment of the invention, the above described packet-marking by means of the priority bit is not used, and mod adapter 56 selects the packets according to a predetermined, programmed list of PID values. This approach is also very easy to be implemented, though it is less flexible, since any change in the programs will require a correction in the software at each of the receiving stations.

[0030] It should be noted that the invention can be applied whenever it is convenient to distribute to the transmitters in an MFN network a multiplexed stream having a higher capacity thatn is transmitted over the individual terrestrial channels, independently of the distribution means (satellite, cable, radio relay, optical fiber).

[0031] A preferred embodiment of the invention nhas been described, though it must be understood that changes can be made to it, as will be obvious for a person skilled in the art. For instance, the distinction between pre-mux 40, mux 44 and MFN adapter 52, as shown on Fig. 2, should be construed in a merely functional meaning, and does not necessarily reflect actual, separate circuit devices, as the steps of the process can be software-implemented, wholly or partly. Even mod adapter 56 could be incorporated in DVB-T modulator 60, thereby allowing certain common functions to be

spared.

Claims

1. A process for transmitting digital television signals, wherein a plurality of elementary binary streams, which are generated in a central generating station and are associated with respective television programs, are multiplexed into a single, low-capacity transport stream, which also incorporates PSU/SU tables packets, PCR packets and null packets, and wherein the transport stream is then modulated and transmitted to a plurality of terrestrial stations, **characterized in that** the transport stream, before modulation, is subjected to the following operating steps:

   - masking the packets which transport PSI/SI tables of type PAT, SDT, NIT e EIT by replacing their respective PIDs with respective, predetermined, hiding PID values, chosen among values that are not reserved for satellite reception;

   - re-multiplexing the transport stream resulting from the preceding step to generate a high-capacity transport stream for transmission.

2. The process for transmitting digital television signals of claim 1, wherein the packets in the low-capacity transport stream each include a "priority" bit, further **characterized in that** the "priority" bit, before remultiplexing, is set to a predetermined value.

3. A process for transforming digital television signals in the form of a high-capacity transport stream which has been generated by the process of claim 1, in order to extract the useful low-capacity transport stream having the same gross bit-rate, including the null packets, **characterized in that** the high-capacity stream is subjected to the following operating steps:

   - modifying the packets having PIDs that are different from a desired selection into null packets, by replacing their PIDs;

   - restoring the original PIDs in the packets transporting the previously hidden PSI/SI tables (PAT, SDT, NIT e EIT), on the basis of a correspondence table.

4. A process for transforming digital television signals in the form of a high-capacity transport stream which has been generated by the process of claim 2, in order to extract the useful low-capacity transport stream having the same gross bit-rate, including the null packets, **characterized in that** the high-capacity stream is subjected to the following operating steps:

   - marking as null packets the packets having a "priority" bit that is not set to said predetermined value;

   - restoring the original PIDs in the packets transporting the previously hidden PSI/SI tables (PAT, SDT, NIT e EIT), on the basis of a correspondence table.

5. The process for transmitting digital television signals of claim 1 or 2, **characterized in that** the modified transport stream is re-multiplexed together with a conventional transport stream for generating a final transport stream for transmission via a satellite link.

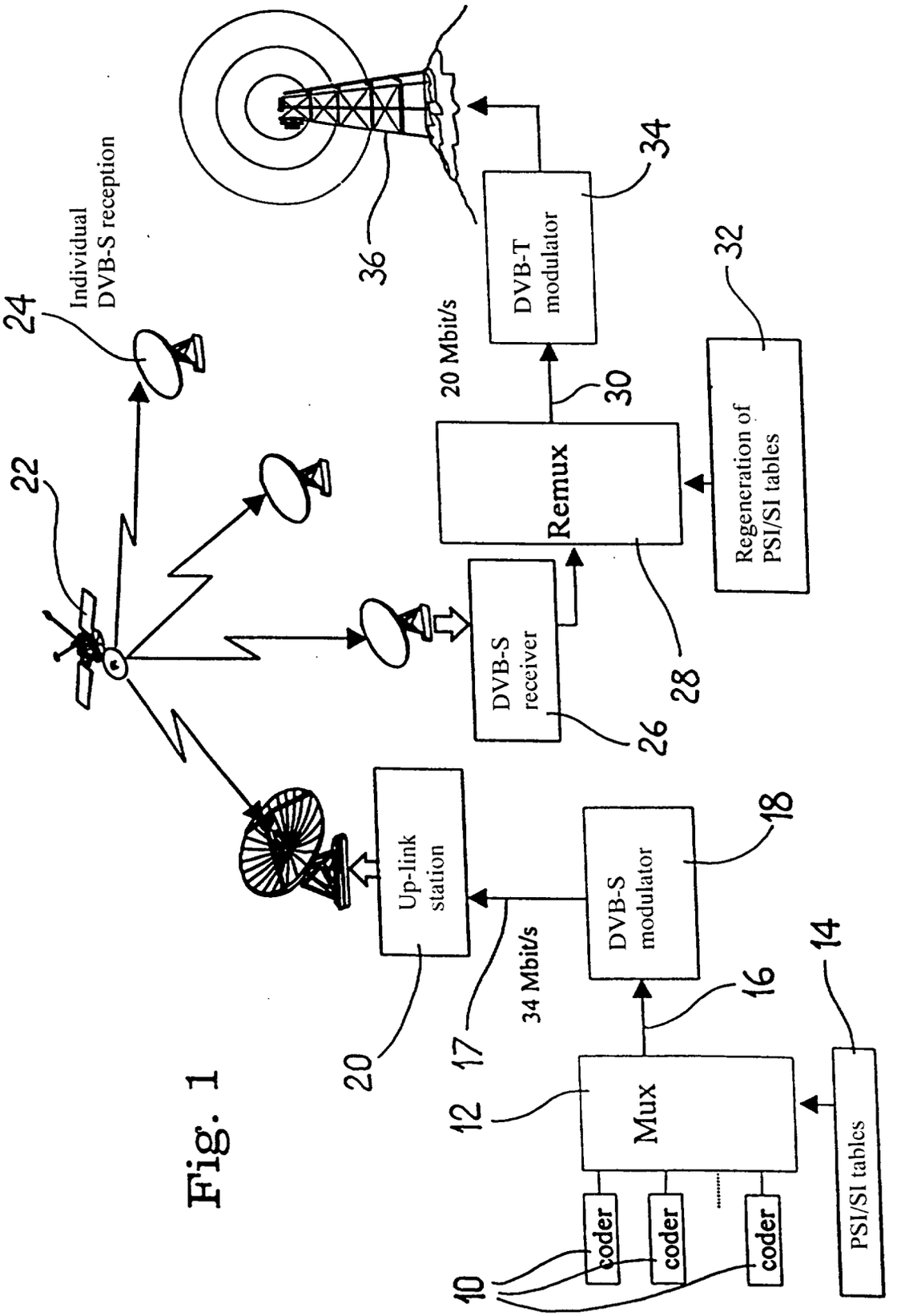
Individual
DVB-S reception
24
22
36
34
DVB-T
modulator
20 Mbit/s
30
32
Regeneration of
PSI/SI tables
Remux
DVB-S
receiver
26
28
Up-link
station
20
17
34 Mbit/s
DVB-S
modulator
18
12
Mux
16
14
coder
coder
coder
10
PSI/SI tables

Fig. 1

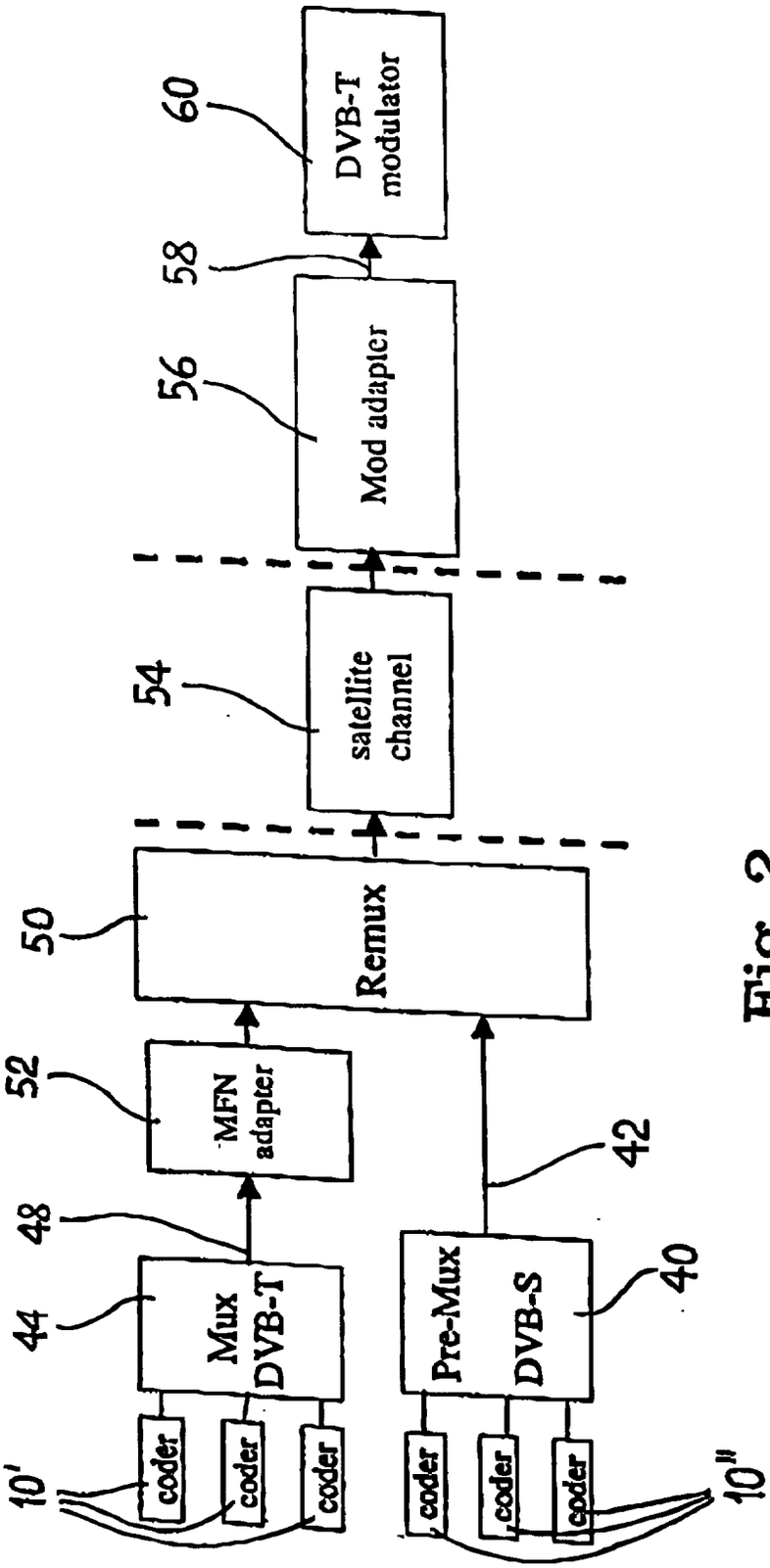
10'
coder
coder
coder
44
Mux DVB-T
48
52
MFN adapter
50
Remux
coder
coder
coder
Pre-Mux DVB-S
40
42
10"
54
satellite channel
56
Mod adapter
58
60
DVB-T modulator

Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 42 5077

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	CARTWRIGHT C T: "ISSUES IN MULTIPLEX AND SERVICE MANAGEMENT IN DIGITAL MULTICHANNEL BROADCASTING" INTERNATIONAL BROADCASTING CONVENTION, LONDON, GB, September 1997 (1997-09), pages 308-313, XP000668937 * the whole document *	1-5	H04N7/24
A	EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE: "Digital Video Broadcasting (DVB); Implementation Guidelines for DVB terrestrial services; Transmission aspects" ETSI TR 101 190 V1.1.1, December 1997 (1997-12), pages 1-77, XP002207123 * section 4.2.2 *	1-5	
A	EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television" ETSI EN 300 744 V1.4.1, January 2001 (2001-01), pages 1-49, XP002207124		TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04N
A	EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE: "Digital Video Broadcasting (DVB); Framing structure, channel coding and moulation for 11/12 GHz satellite services" EN 300 421 V1.1.2, August 1997 (1997-08), pages 1-24, XP002207125		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 July 2002	Hampson, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)